

ATMOSPHERIC PHYSICS

Corrections and Additions for the HITRAN Water Vapor Spectroscopic Database

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Systematic errors have been found and corrected in the HITRAN (High-Resolution Transmission Molecular Absorption Database) water vapor line absorption intensities in the visible and near-infrared spectral regions. The HITRAN database has been used extensively in the calculation of atmospheric absorption of solar radiation. The most important corrections found were a 14.4% increase of the intensity of the 940-nanometer (nm) band and an 8.7% increase of the intensity of the 820-nm band. These systematic errors in the HITRAN tabulations were due to errors in the unit conversion from the measurements published in centimeter/(centimeter atmosphere) ($\text{cm}^{-1}/(\text{cm-atm})$) to the HITRAN common units $\text{cm}^{-1}/(\text{molecule}/\text{cm}^2)$. Because the absorption of water vapor in these important regions is greater than has been used in model calculations for the Earth's atmospheric absorption, there is a diminished necessity for an hypothesized "continuum absorption" in the atmosphere.

These corrections have been applied to the HITRAN water vapor line list above 8000 cm^{-1} and have been submitted to HITRAN for posting on its website update page. In addition, measurements and assignments of some weak water vapor lines in this region (not included in the HITRAN list) have been reported.

Prasad Varanasi (State University of New York at Stony Brook) and Richard S. Freedman (SPRI) collaborated in this research.

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How Effectively Can Freeze-Drying by Optically Thin, Laminar Cirrus Dehydrate Air Rising Slowly Across the Tropical Tropopause

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Over the past 20 years, many theories have been proposed to explain the extreme dryness of air in the tropical lower stratosphere. Recent observations suggest that the flux of air into the stratosphere may be dominated by slow ascent across the tropopause throughout much of the tropics. In this study, cloud model simulations were used to show that laminar, optically thin cirrus clouds (frequently observed near the tropopause) can effectively freeze-dry air entering the tropical stratosphere. A detailed ice cloud microphysical model coupled to a large-eddy simulation dynamical model was used for these simulations. As shown in the top panel of the figure, if no cloud forms, the slow ascent across the tropopause will eventually increase the water vapor mixing ratio above 5 parts per million by volume (ppmv). These values are much higher than observed water vapor mixing ratios. However, if we include cloud formation, then the slow ascent drives adiabatic cooling and nucleation of a small number of ice crystals ($<10/\text{liter}$). These crystals grow rapidly and precipitate out within a few hours. The ice crystal nucleation and growth prevents the relative humidity (with respect to ice) from rising above the threshold of ice nucleation (130–160%) and limits the water vapor mixing ratio above the tropopause to 3–4 ppmv (bottom panel of figure). The nucleation threshold depends upon the aerosol composition in the tropopause region, which is not well known. Simulations including gravity waves propagating through the model were also done. Temperature oscillations driven by the waves drive nucleation of larger ice number densities and more complete dehydration of the rising air. These conditions promote the effectiveness of upper tropospheric aerosols as ice nuclei and the climatology of waves in the tropopause region. In situ tropical humidity observations from several field experiments have been gathered. These measurements included accurate water vapor sensors mounted on the NASA ER-2 as well as balloon-borne instruments. The humidity observations provide a few